

Math Anxiety in Pre-Licensure Nursing Students: a Pilot Study

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Project Manuscript

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Abstract

Background

Math anxiety is a common phenomenon among nursing students. A review of the literature has revealed that math anxiety interferes with student cognition which could ultimately lead to patient harm. The purpose of this project is to determine if a basic math tutorial affects levels of math anxiety in pre-licensure students at the University of Alaska Anchorage (UAA).

Methods

Thirty-five students were randomly assigned to an experimental or control group. Math anxiety was measured with the Abbreviated Math Anxiety Rating Scale (AMARS). The experimental group participated in a math tutorial while the control group quietly waited outside of the classroom.

Results

There is no evidence that the math tutorial was useful in reducing math anxiety.

Conclusions

Both groups of participants had a decrease in math anxiety, yet it is uncertain how significantly the math tutorial (Appendix E) affected their math anxiety levels.

Key Words: math anxiety, Abbreviated Math Anxiety Rating Scale, math tutorial, nursing students

Introduction

Nurses must be able to routinely perform math calculations; however, research has shown that nurses have difficulty performing these calculations with accuracy. Math anxiety, an inability to cope with quantification, contributes significantly to these difficulties (Perry, 2004). According to Perry (2004), math anxiety is an extremely common phenomenon among college students today. Although math anxiety is not a learning disability, it functions as one in the sense that it has negative personal, educational, and cognitive consequences (Ashcraft & Moore, 2009). Causes of math anxiety vary, but educators agree that math anxiety primarily stems from student fears of failing and feelings of inadequacy (Perry, 2004). Math anxiety interferes with student cognition. When students with math anxiety perform calculations, the risk of error is much higher than in students without math anxiety. Additionally, students with math anxiety tend to intentionally avoid math courses and anything related to math.

However, math in nursing programs is inevitable. It is common for nursing programs to administer a drug dosage calculation test at the beginning of each semester to evaluate student preparedness. Students are typically required to earn a perfect or near-perfect score on this test because math skills are needed by nurses to safely administer medications (Harvey, Murphy, Lake, Jenkins, Cavanna, & Tait, 2010). Rainboth and DeMasi (2006) explain that nurses have always been and continue to be the last line of defense against medication errors. For this reason, math anxiety needs to be addressed in nursing school before students enter professional practice. There is no simple solution to the problem of math anxiety but there are interventions to help reduce levels of math anxiety.

Purpose

The purpose of this project is to determine if a basic math tutorial affects levels of math anxiety in pre-licensure nursing students at the University of Alaska Anchorage (UAA). This project will aim to answer the following question: Will a basic math tutorial affect math anxiety levels in pre-licensure nursing students? If results reveal that the math tutorial significantly decreases math anxiety, it could be implemented in pre-licensure nursing programs.

Review of Literature

Richardson and Suinn (1972) define math anxiety as, “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of math problems in a wide variety of ordinary life and academic situations” (p. 551). Like any type of anxiety, levels of math anxiety range from mild to severe. The mildest form of math anxiety occurs in students who understand math concepts during class and homework assignments but panic and experience paralysis of thought during exams. The most common level of math anxiety is moderate. These students are frequently frustrated with math and have a difficult time learning and remembering math concepts. Symptoms of math anxiety are often physiological. Students with severe math anxiety manifest their fears through symptoms such as sweaty palms, nausea, and heart palpitations (Perry, 2004). At extreme levels, math anxiety may prevent a student from passing fundamental math courses or prevent his or her pursuing of advanced courses in mathematics or science (Richardson & Suinn, 1972). However, in most cases math anxiety is not this extreme.

The Math Anxiety Cycle (MAC) begins when a student develops math anxiety, likely due to negative experiences with math in the past. Students with math anxiety tend to avoid situations involving math which leads to poor math performance, causing increased anxiety, and

reduced confidence (Ashcraft & Moore, 2009). The MAC can repeat itself frequently so that eventually the student with math anxiety becomes convinced of his or her inability to perform any type of math (Preis & Biggs, 2001). Students with math anxiety experience long term effects; they avoid elective math courses, college majors that require math, and avoid career paths, such as nursing, that involve math (Devine, Fawcett, Szucs, & Dowker, 2012).

A 2011 study at University of Chicago study examined brain activity in students with high levels of self-identified math anxiety. Researchers analyzed college students ($N = 32$) ages 18-25 with varying levels of math anxiety. Students were scanned by magnetic resonance imaging (MRI) while performing a series of equally challenging math and spelling questions. Before each question was presented, a symbol was shown telling students if the question would be math or spelling related. The MRI was able to identify a student's anxiety about the upcoming question based on brain activity. As expected, highly anxious students performed less accurately in both subjects than less anxious students. According to Sparks (2011), highly anxious students who performed well had high levels of activity in the frontal and parietal regions of the brain when signaled that a math problem was coming up. The frontal and parietal regions of the brain are responsible for cognitive control, focus, and regulation of negative emotions, not numerical calculations. The findings of this study suggest that interventions can be developed to help students with math anxiety control their emotions when faced with a stressful math situation (Sparks, 2011).

Glaister (2007) conducted a study to determine if math anxiety in nursing students affects the learning of drug dosage calculations. The study used convenience sampling of second year nursing students ($N = 97$) in Australia. Using a randomized design, participants were exposed to one of three instructional methods: computerized learning, integrative learning, or a

combination of computerized and integrative learning. Levels of math anxiety were then compared based on each instructional method. Data was collected using a dosage competency assessment administered six weeks after the instructional approach was completed. Results revealed that 20% ($n = 19$) of the student nurses had math anxiety and 14% ($n = 13$) had math testing anxiety. Students with the highest anxiety benefited from the integrative learning method. Results revealed that significant math anxiety exists in nursing students. In addition, students who reported a negative attitude towards math were more likely to perform poorly than students reporting a greater level of comfort with math. Students with negative attitudes were best assisted in gaining conditional knowledge when they were exposed to approaches that offered integrative learning. This study concluded that integrative styles of learning should be used in future teaching practices, especially when dealing with anxiety generating content such as math (Glaister, 2007).

Ashcraft and Moore (2009) conducted a study that produced similar results. The purpose of this study was to identify important findings about math anxiety and indicate how math anxiety relates to other performance measures. They hypothesized that “math achievement and proficiency scores for individuals with math anxiety are underestimates of true ability” (p. 197). To test this hypothesis, they conducted a study investigating possible cognitive consequences of math anxiety when people perform math-related tasks. Ashcraft and Moore (2009) found that the higher one’s level of math anxiety, the lower one’s score is on math achievement tests, the fewer math courses one takes, and the lower one’s grades are in math courses that are taken. Additionally, those with higher levels of math anxiety have poorer attitudes about math which influences decisions about college majors and career paths. Their results indicate that each time an individual with math anxiety is asked to perform math in a

timed, high-stakes setting, the individual's math anxiety is aroused which causes a significant decline in performance (Ashcraft & Moore, 2009).

Relevance to Nursing Education

Math anxiety is an important educational issue that directly relates to math achievement (Walsh, 2008). In terms of patient safety, calculating drug dosages is a crucial aspect of nursing practice. Due to pharmaceutical pre-preparations and electronic medication pumps, nursing students have less exposure to drug dosage calculations. Despite this, nurses must be prepared to perform calculations by hand when working outside of high-tech areas (Jukes & Gilchrist, 2006). A literature review reveals that many pre-licensure nursing students lack proficiency with basic math skills, particularly those skills necessary for safe medication preparation and administration. This lack of proficiency is concerning to nursing educators (Dyjur, Rankin, & Lane, 2011). As early as the 1960s, researchers have identified a need for increased math competency in nurses (Rainboth & DeMasi, 2006). A literature review conducted by Revell and McCurry (2013) aimed to evaluate pedagogies for teaching math, identify curriculum strategies, and identify challenges faced by pre-licensure students in understanding math. Of the articles reviewed ($N = 51$), studies were primarily published in the United Kingdom ($n = 14$) and the United States ($n = 29$). The literature revealed several student challenges that impact math competency: inadequate pre-college math preparation, inability to comprehend problem solving strategies, lack of contextual understanding, and anxiety (Revell & McCurry, 2013). Educators are continually faced with students who lack basic math skills (Rainboth & DeMasi, 2006). Educators are challenged to develop innovative teaching and learning approaches that meet the needs of learners and result in achievement of the conceptual and practical use of solving math problems for medication administration (Revell & McCurry, 2013).

Wright (2005) conducted a research project among second year British nursing students to determine the most effective way to teach drug calculations. The researcher became overwhelmed and frustrated with the lack of student math knowledge during her classes so she used a diagnostic test to assess student ability. The diagnostic test, completed by 70 students, revealed a mean score of 53%. Main areas of difficulty were sections on multiplying fractions, ratios, and interpreting information. Wright (2005) then conducted a math tutorial session reviewing these topics. The following conclusions resulted from her tutorial: highlighting areas of math difficulty causes anxiety in students, teaching math to a large class (fifty or more students) was not effective, and that use of a calculator was not a substitute for math skills. Based on these conclusions, the researcher made changes to her math teaching methods: the creation of a virtual learning environment for students to practice math problems was created and calculations were taught in context to nursing practice. Although a repeat math exam was not administered, the researcher identified several strategies that improved her teaching practice and are applicable to other programs (Wright, 2005).

In 2012, Wright conducted further research to evaluate student perceptions of learned drug calculation skills. A semi-structured questionnaire was given to second year British nursing students ($N = 67$) to explore their perceptions of teaching and learning strategies implemented during a nursing course. Three major themes emerged regarding how students prefer to learn drug calculation skills: they desire to have feedback about their progress, prefer to learn in their own way, and like to focus on doing drug calculations in the real world. Wright (2012) explains that student goals are achieved most easily through math tutorial sessions. Students preferred a math tutorial that provided content at a basic level.

According to Dyjur, Ranking and Lane (2011), nursing educators equate math competency on an exam to medication administration competency in clinical practice. When students are successful on a math exam, educators feel confident and secure about students administering medications. Yet, when students are unable to demonstrate competence on a math exam, educators deem them unsafe in clinical practice which leads to anxiety and frustration. Educators cannot assume that success on a math test equates to safe medication administration. Students must also know how to make sense of the numerical information that results from math operations. The literature has raised additional concerns about the reliability and validity of math competency exams. The concern with a math proficiency exam is that it is not contextualized; it is based on calculations from textbooks, not clinical scenarios. Students take the exams in a classroom with a paper and pencil and no distracting background noises. In the clinical environment, drug dosage calculations are usually done orally amidst the sights, sounds, smells, and other distractions of a clinical setting. In addition, nurses are permitted to seek assistance from co-workers when they are unsure about a calculation. This is not true in the classroom environment (Dyjur, Rankin, & Lane, 2011).

Rainboth and DeMasi (2006) conducted a study to evaluate the efficacy of a teaching strategy in improving math competency of beginning nursing students. The study, based on the information processing theory, used a pre-test/post-test design to determine if mandatory medication calculation classes and mandatory math calculation assignments would improve performance on a major medication calculation exam completed by ninety-three nursing students. A paired *t*-test revealed that the intervention group scored statistically significantly better on the post-test than the pre-test. Results validated the theory that a deficiency in math skills can be improved at the nursing school level. In addition, students had favorable comments

about the interventions and felt that they benefited from the mandatory class and assignments. Students also revealed that the teaching intervention decreased their anxiety regarding the major medication calculation exam and improved their perception of their own math ability. A convenience sample of primarily Caucasian female students limited the results of this study. Internal validity was threatened by the pre-test and post-test design because the same questions appeared on both in the same order (Rainboth & DeMasi, 2006)

A few years later, Bull (2009) confirmed that teaching interventions decrease math anxiety. Bull (2009) conducted a study hypothesizing that high math anxiety is associated with knowledge of having a skills deficit. In this study, student nurses ($N = 63$) were given a math test and a questionnaire about their anxiety levels related to the test. The first part of the study was conducted in the second week of the course. Eight weeks later, the second phase took place and students were given another test and questionnaire. However, prior to the second phase, there was a period of focused math practice. Results revealed that 45% of the students had a high level of math anxiety prior to test one. After the intervention in phase two, 33% of students reported high anxiety. According to Bull (2009), written comments supported these quantitative results. Students in this study reported a level of math anxiety that was related to their level of math error. Bull (2009) suggests that math anxiety of some students was exacerbated by the calculator free format on the test. However, students must be able to function in a technology free environment in the event that situations arise where technology is unavailable. Focused practice alleviated a significant amount of anxiety in the students, indicating that a lack of knowledge was a major contributor to their initial anxiety levels. Bull (2009) recommends that self-evaluation of math anxiety be conducted early in nursing programs.

There is no simple solution to the problem of math anxiety in nursing students. Despite this, it is important that students acknowledge their anxiety and formulate a plan to minimize it. Seeking assistance early is one step in easing math anxiety. However, any solution starts with proactive attitudes from students and educators (Perry, 2004). Just as with other types of anxiety, students may find relief by utilizing coping strategies that are natural and direct. Bull (2009) suggests that math anxiety may be decreased by raising awareness of the risk of math anxiety to math performance, introducing self-evaluation of math anxiety prior to math tasks, and clarifying remedial strategies based on causative or associate factors. Students must also feel comfortable in their learning environment so that they can ask questions and direct their energy toward solving their math anxiety (Perry, 2004). According to Bull (2009), psychological techniques to calm anxiety can be beneficial to math anxiety sufferers. However, this basic approach overlooks the possibility that a student's math anxiety arises from a lack of proficiency or preparedness. Bull (2009) argues that in many cases, students with math anxiety would benefit more from pedagogical or course-administration remedies, than from psychological methods.

Causes of Math Anxiety

Significant research on math anxiety began in the 1970s with the development of the Math Anxiety Rating Scale (MARS) (Ashcraft & Krause, 2007). Since then, many theories have developed about the causes of math anxiety. According to Bull (2009), math anxiety may be caused by factors such as a calculator-free test format, a poor command of basic math skills, or feeling unprepared due to not having enough time to prepare. Perry (2004) and Ashcraft and Moore (2007) speculate that math anxiety forms at a young age when students are embarrassed in front of their peers for being slow or incorrect with basic math calculations. Other students

have low self-efficacy because they have been discouraged to succeed in math due to gender bias or insensitive educators (McMullan, Jones, & Lea, 2012).

Dyjur, Rankin, and Lane (2011) argue that math anxiety is a result of a culture of blame. Students frequently use past instructors as scapegoats for their math problems. These negative experiences related to math can be detrimental to adult learners. Historically, nursing programs have taught math skills in a manner that reinforces a culture of blame. For example, calculation skills are taught, assessed, and reinforced infrequently. A long gap between practicing math limits opportunities for students to maintain math proficiency. This presents a major barrier since the process of learning mathematics at any age is made easier by repeated practice and exposure. The lack of practice opportunities can actually lead to anxiety when students are faced with drug dosage problems (Dyjur, Rankin, & Lane, 2011). Anxiety levels tend to increase when students understand computational math skills but lack the conceptual understanding and mental framework to organize his or her knowledge (Perry, 2004). Once math anxiety is established, it tends to be supported by cultural attitudes that math is hard or that one is not good at math regardless of how hard he or she works (Ashcraft & Krause, 2007).

It is clear that the higher one's math anxiety, the lower one's math learning, mastery, and motivation. For this reason, individuals with math anxiety receive poorer grades in math classes they take, show minimal motivation to take more elective math courses, and learn less than their counterparts with low math anxiety. However, students who undergo effective interventions for their math anxiety are able to achieve math scores within the normal range (Ashcraft & Krause, 2007).

A recent study conducted among second year British nursing students aimed to explore factors that influence the development of drug calculation ability, including math anxiety, math self-efficacy, and numerical ability (McMullan, Jones, & Lea, 2012). Using a cross-sectional design and a convenience sample, researchers obtained data with five different tools to measure math anxiety, math self-efficacy, drug calculation self-efficacy, numerical ability, and drug calculation ability. Data relating to anxiety was collected using an adaption of the MARS. This adapted scale, known as the Mathematics Attitude Scale (MAS) consists of 10 items using a Likert scale and has strong internal consistency and stability. Results revealed significant correlations between all variables. Cross-tabulation results indicated that 93% of students who failed the numeracy test and 83% of students who failed the drug calculation test had math anxiety. Significant negative relationships were found between students' levels of math anxiety and their levels of self-efficacy and ability in performing numerical and drug calculations (McMullan, Jones, & Lea, 2012).

A similar study by Jukes and Gilchrist (2006) looked at the ability of British nursing students to perform math drug calculations. Second year nursing students ($N = 37$) completed a 10 item drug calculation exam consisting of questions requiring simple division, multiplication, percentages, ratios, percentages, and unit conversions. The mean score was 5.5 out of 10. None of the students achieved a perfect score and only three were able to earn 9 out of 10 points. Poor math performance can be the result of many factors, one of them being math anxiety, which frequently interferes with math cognition (McMullan, Jones, & Lea, 2012). Results of this study were concerning and it was recommended that this nursing program test math skills regularly and reinforce drug calculation skills in the classroom and clinical setting (Jukes & Gilchrist, 2006).

These results are consistent with a quantitative and qualitative study by Walsh (2006) that examined relationships among math anxiety, beliefs about math, math self-efficacy and performance of nursing students on a medication administration exam. Associate degree nursing students ($N = 108$) in a U.S. program took a 10 item math test containing typical drug dosage calculation problems. Qualitative data was collected using an open-ended questionnaire about math anxiety, beliefs about math, math self-efficacy, and their relationships to performance on a medication math exam (Walsh, 2006). Quantitative data was collected from a 10 item math test that contained typical drug dosage calculations.

Results from the questionnaire revealed that students experienced math anxiety at the level of “slightly agree.” In the open-ended questions, students described math test anxiety as “confusing, frustrating, stressful, strained, and freaked” (Walsh, 2006, p. 227). In this study, students were more anxious about math exams rather than math itself. Students explained that anxiety stemmed from the fact that they were only allowed to make one mistake. Students expressed the belief that math is important and relevant in their lives, especially professionally. Walsh (2006) states that increased math anxiety levels are a function of the students’ recognition that skills involved in dosage calculations have serious implications beyond just obtaining a wrong answer. In general, participants in this study expressed confidence in their ability to perform basic and complex math skills. In concurrence with Bull (2009) and Rainboth & DeMasi (2006), this study concluded that math anxiety levels decrease and confidence increases as a result of focused mathematics tutoring and practice. Walsh (2006) recommends that educators offer math tutoring and remediation through campus services outside the nursing department. Students may feel more comfortable learning medication math skills with tutors who are not evaluating them in their clinical courses (Walsh, 2006).

Theoretical Framework

This pilot study is based on the attentional control theory; a theory that accounts for the effects of anxiety on cognitive performance (Derakshan & Eysenck, 2009). The attentional control theory states that anxiety is associated with adverse effects on cognitive performance, especially in tasks that require focused attention. The brain processes information in two ways: automatic or controlled. With automatic processing, cognition occurs with very little effort. The brain is given a specific stimulus and processing does not interfere with other mental processes. In contrast, controlled processing is cognitively demanding. It relies primarily on serial processing and is responsible for self-regulation. Tasks that require focused attention rely on pre-existing information in one's memory, including an expectation of what might occur while engaging in the task (Eysenck, Derakshan, Santos, & Calvo, 2007).

The attentional control theory explains that anxiety decreases focused attention on concurrent task demands (Derakshan & Eysenck, 2009). Derakshan and Eysenck (2009) state that anxiety impairs performance, especially when the task being performed is complex and attentionally demanding. This theory directly correlates to the purpose of this study because students with math anxiety tend to perform at lower levels. For this reason, interventions are needed to help decrease math anxiety in nursing students. According to Glaister (2007), students with a greater negative attitude about math are more likely to perform less well than those students reporting a greater level of comfort with math. This pilot study aims to demonstrate a method of decreasing math anxiety levels so that students will be able to perform math calculations more accurately.

Methods

Setting and Participants

Study participants were obtained through convenience sampling at the UAA School of Nursing. All participants were enrolled in the baccalaureate nursing program. Incentives were offered for participation. At the completion of the study, two participant names were drawn and each won a \$25 gift card to Moose's Tooth Restaurant. All participants signed the informed consent (see Appendix A). The study took place in a classroom of the UAA Health Sciences Building (HSB). The project was approved by the UAA Institutional Review Board (IRB).

Instrument

The gold standard for identifying math anxiety is the math anxiety rating scale (MARS) constructed by Richardson and Suinn (1972). It consists of 98 statements related to math situations that are rated by the participant (Bull, 2009). The participant recalls his or her anxiety level for that situation and rates it on a 1-5 Likert scale with 5 being the highest amount of anxiety (Bull, 2009). Responses range from no anxiety to extreme anxiety (Ashcraft & Moore, 2009). Ratings are compiled and then compared with normative data that categorizes the extent to which the participant suffers math anxiety. When used in other studies, the MARS item most commonly rated as most stressful is "the thought of taking a math test" (Bull, 2009, p. 73). Bull (2009) states that research using the MARS has been valuable in determining the existence and nature of math anxiety in college students. Due to the length of the MARS, an abbreviated form is frequently used (Alexander & Martay, 1989).

In this pilot study, the abbreviated MARS (AMARS) was used to measure math anxiety with permission from the author, Livingston Alexander. The original MARS was not used in this

study since previous researchers have determined that its length is a barrier to receiving accurate results (McMullan, Jones, & Lea, 2012). The AMARS (Appendix B) consists of 25 Likert scale statements related to math scenarios. It is scored by awarding 1 through 5 points, respectively for participant responses. According to Ashcraft and Moore (2009), the mean score across many college samples is 36.0 ($SD = 16$). Compared to other math anxiety instruments, the MARS has the greatest amount of psychometric, reliability, and validity data (Dew, Galassi, & Galassi, 1983). Richardson and Suinn (1972) explain that evidence for validity comes from three studies in which MARS scores showed expected decreases following behavior therapy for mathematics anxiety, and a separate validity study in which MARS scores were found to correlate negatively with scores on a mathematics test.

Study Design and Procedures

A pretest-posttest experimental design was used to identify differences in math anxiety levels between experimental and control groups. The researcher emailed pre-licensure nursing students at UAA and provided an overview of the study with an informed consent form attached. Interested students replied with consent forms (Appendix A) filled out. The researcher also collected signed consent forms when participants met in the UAA HSB for the study.

All participants met in a classroom at the UAA HSB. The researcher provided a brief overview of the study to participants. All consent forms were collected prior to initiating the study. Prior to distributing AMARS questionnaires, they were labeled “A” or “B” by the researcher. The AMARS and demographic (Appendix C) questionnaires were then distributed to participants. After completion of both forms, participants were randomly assigned to the control or experimental group based on a coin toss. The coin toss determined that participants with “A”

on their A-MARS questionnaire belonged in the experimental group and those with “B” in the control group.

After groups were determined, those in the control group were dismissed and instructed to check their email for instruction about completing the post-intervention AMARS in four weeks. Participants in the experimental group remained seated in the classroom and received a math tutorial (Appendix E). The math tutorial focused on three topics that participants will encounter in the nursing profession: interpreting ratios, converting units of measurement, and carrying out medication dosage calculations. With permission from the author, this tutorial was adapted from an online medication calculation tutorial by Hansen (2009). Current literature was also reviewed in the process of developing this math tutorial. In a study by Wright (2012), participants provided qualitative data supporting the use of a tutorial applicable to the real world. Additionally, Coyne, Needham, and Rands (2013) explain that a medication tutorial provides a non-confronting environment for students to receive remediation of medication calculation.

When the math tutorial was completed, participants were dismissed and instructed to check their email about instruction for completing the post-intervention AMARS. Four weeks later, participants returned to complete the post-intervention AMARS questionnaires. AMARS questionnaires were labeled “A” or “B” according to the original experimental and control groups. Participants were given an “A” or “B” questionnaire based on their assigned group from the previous meeting. Participants were then debriefed (Appendix F) and the drawing for the gift cards took place.

Results

A total of thirty five students participated in this pilot study divided between the experimental ($n = 17$) and the control group ($n = 18$). The coin toss determined that participants with “A” on their A-MARS questionnaire belonged in the experimental group and those with “B” in the control group. All analyses were conducted using Statistical Analysis System (SAS) Version 9.4. Of the thirty five participants in the study, 30 were female and 5 were male. The average age was 28.17 years ($SD = 5.84$). The demographic questionnaire asked participants about math experience from a previous job or career. Only 14% ($n = 5$) of participants indicated that they had math experience from a previous job or career. On the demographic questionnaire, most participants ($n = 31$) provided the date of the last formal math course they had taken. The length of time since the last math course was calculated as the number of years from that date to November 1, 2014. Dates ranged from December 2007 to August 2014. The number of months since the last math course was also calculated. The average time since a student had taken a formal math course was 3.57 years ($SD = 1.70$) or 42.87 months ($SD = 20.50$).

Participants were instructed to fill out A-MARS questionnaires completely, however some contained missing responses. In the pre-test group of questionnaires, one survey had two missing responses and five surveys had one missing response. In the post-test group of questionnaires, one survey had two missing responses and five surveys had one missing response. None of the questionnaires had more than two missing responses, so the researcher chose to include all scores in the analysis.

The sample sizes of $n = 17$ and $n = 18$ were too small to calculate Cronbach’s Alpha separately for the experimental and control groups. In order to verify internal consistency of the

instrument, the researcher calculated Cronbach's Alpha for the entire group of pre-test surveys (0.95) and again for the post-test surveys (0.94). Bedeian and Field (2002) recommend calculating an independent samples t value, and using the degrees of freedom appropriate for a paired-samples t -test. At the 0.05 level of significance the researcher finds that, although both groups showed a decrease in math anxiety level from pre to post intervention, neither of these groups showed significant improvement after the intervention. There was no significant difference in pre and post intervention AMARS scores between the experimental ($t = 1.66, p = .12$) and the control group ($t = 1.74, p = .10$) (Table 1).

Table 1. Summary of Results

	<u>Pre-Intervention</u>		<u>Post-Intervention</u>	
	<u>t-value</u>	<u>df</u>	<u>p-value</u>	
Experimental	1.66	16	0.11	
Control	1.74	16	0.10	

Based on this data, there is no evidence that the math tutorial intervention was useful in reducing math anxiety.

Discussion

Math is an inevitable part of the nursing curriculum and is should be addressed early in a student's career. The results of this study have revealed that a math tutorial is a possible effective intervention for decreasing math anxiety. Both groups of participants showed a decrease in math anxiety, yet it is uncertain how significantly the math tutorial affected their math anxiety levels. Since participants in the control group also had decreased math anxiety, it is possible that they

may have received additional help with math related to their nursing courses during the four weeks between pre-test and post-test surveys. They also may have received more practice in the clinical setting which could have boosted their confidence and decreased their anxiety. In this study, no interaction occurred between the researcher and the participants between pre-intervention and post-intervention surveys. Therefore it was not possible to control how much or how little the students practiced math throughout the course of the study.

It is unknown if participant age affected pre-test or post-test anxiety levels. Literature on math anxiety in nursing students does not discuss age as a factor. In this study, it was not possible to calculate the mean age for each group of participants because demographic questionnaires were completed and collected by the researcher prior to dividing participants into control and experimental groups. Due to the study design, individual AMARS questionnaires could not be linked to individual demographic questionnaires. More relevant demographic characteristics are levels of math experience and length of time since last math course. In this pilot study, the average time since a participant had taken a math course was 3.57 years. The majority of participants ($n = 30$, 85.71%) had no math experience from a previous career. The fact that most participants had no experience with math from a previous career and have not taken a math course for several years highlights the need for a range of teaching strategies that support gradual introduction of math concepts and practice throughout the semester (Coyne, Needham, & Rands, 2013). Since the researcher did not know the background of the participants prior to designing the intervention, it is possible that the math tutorial was not effective as a single intervention.

Analyzing results from the A-MARS reveals that participants were most anxious and least anxious about the same math related scenarios before and after the intervention (Appendix

D). The fourth statement on the AMARS produced high anxiety for participants. It asks participants about their anxiety level when they think about taking a final exam in a math course. Before the intervention, the mean score for this statement was 3.72. After the intervention, the mean score was 3.04. The fifteenth statement on the AMARS asks participants to rate their anxiety about being given a pop quiz in a math class. Before the intervention, the mean score for this statement was 3.76. This is the highest mean score for any individual statement on the AMARS. After the intervention, the mean score for this statement was 3.0. Participants had the least anxiety about the fifth statement on the AMARS which asks participants to rate their anxiety about picking up a math textbook to begin a homework assignment. Before the intervention, the mean score for the statement was 1.55. After the intervention, the mean score decreased to 1.36.

This pilot study is important because many nursing students experience math anxiety (Bull, H, 2009; McMullen, Jones, & Lea, 2012; Walsh, 2006). Math anxiety is a significant educational issue that is directly related to math achievement (Walsh, 2006). Nursing faculty, especially those who teach beginning nursing students, should consider assessing math anxiety in their students. However, further research is needed to determine if a basic math tutorial is the best intervention.

Limitations

This study had several limitations. In order to improve results of this study, it may have been helpful to determine if any participants had pre-existing generalized anxiety or were undergoing treatment for an anxiety related condition. If any participants had pre-existing generalized anxiety, the researcher would expect higher levels of math anxiety. Additionally, results of this study may have been more useful if study methods would have linked individual

surveys with demographic questionnaires. For example, when performing the data analysis, it was not possible to determine if the participants who had math experience from a previous career were in the control or experimental group. Another limitation was the skipped responses on participant surveys. Although participants were instructed to complete all questions on the surveys, it was not possible to ensure 100% completion.

The generalizability of this study is also limited. It was conducted at one university with a convenience sample of students who were similar in race, ethnicity, and gender. However, this was a pilot study, so the number of study participants ($n = 35$) was adequate.

Conclusion

The literature provides evidence that math anxiety in nursing students decreases after educators provide interventions. This pilot study did not demonstrate that a basic math tutorial is the best option for reducing math anxiety in nursing students. However, it did demonstrate that math anxiety is present in pre-licensure nursing students. Neither the experimental or control groups showed significant improvement after the intervention. This study should be repeated with a larger sample size and more frequent and in depth interventions. It would also be beneficial to factor in the component of math competency by having participants complete a math test before and after the intervention. It would be interesting to analyze if the risk of error is truly higher in students with math anxiety.

When nursing educators know that math anxiety exists among their students, it is important that they consider evidence based interventions. Math anxiety interferes with student cognition and is a significant impediment to math achievement. Due to routine nursing tasks that require math skills, it is essential that nursing educators provide interventions to reduce anxiety so that math errors do not lead to patient harm.

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Appendix A

CONSENT FORM

PRINCIPAL INVESTIGATOR:

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PROJECT COMMITTEE CHAIR:

Patricia A. Lynes-Hayes, PhD, RN
Assistant Professor, School of Nursing
University of Alaska Anchorage
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DESCRIPTION:

I am interested in investigating math anxiety levels among pre-licensure nursing students. There are two parts to this study. In the pre-test, you will be asked to complete the Abbreviated Math Anxiety Rating Scale (A-MARS) and answer four demographic written questions which will take approximately 15 minutes. You will then be divided into two groups. Groups will be determined by coin toss. One group will receive a math tutorial lasting 20 minutes. The tutorial will take place in the UAA Health Sciences Building. The control group will not participate in the tutorial. Four weeks after this takes place, the post-test will take place and you will be asked to complete the A-MARS again.

CONFIDENTIALITY

All consent forms and questionnaires will be shredded one year after this project is completed. Names or any other identifying information will not be written on surveys. Any published data from this study will not reveal names.

BENEFITS:

There will be no direct benefits derived from participation in this study.

INCENTIVES

After all data have been collected, participant names will be entered in a drawing for two (2) \$25 gift certificates from Moose's Tooth. Consent for participation in incentive drawing on separate form.

RISKS:

There are no known anticipated risks involved with participation. However, if you experience a level of anxiety that makes you uncomfortable, you may contact the UAA student health center (907-786-4040) for evaluation.

POINTS OF CONTACT:

If you have any questions about this project, you may contact the Principal Investigator at the phone number listed above or my committee chair, Patricia A. Lynes-Hayes, PhD, RN at 907-786-4604. If you have any questions about your rights as a research participant please contact Dr. Dianne Toebe at the University of Alaska Anchorage at (907) 786-1099.

VOLUNTARY NATURE OF PARTICIPATION:

Participation in this study is voluntary. If you do not wish to participate, or would like to terminate your participation at any time, there will be no penalty and your grade will not be affected in any way.

SIGNATURE:

By signing below, you have freely agreed to voluntarily participate in this research study. You should consent only if you have read this form and you fully understand its content. If you have any questions about this study, please feel free to ask them now or at any time throughout the study.

Printed Name_____

Date_____

Signature _____

Date_____

Appendix B

Abbreviated Math Anxiety Rating Scale (Alexander & Martray, 1989)

ABBREVIATED MATHEMATICS ANXIETY RATING SCALE (A-MARS) QUESTIONNAIRE

Please indicate the level of your anxiety in the following situations. Please choose ONE box on each line.

	Not at all	A little	A fair amount	Much	Very much
1. Studying for a math test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Taking math section of the college entrance exam.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Taking an exam (quiz) in a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Taking an exam (final) in a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Picking up math textbook to begin working on a homework assignment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Being given homework assignments of many difficult problems that are due the next class meeting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Thinking about an upcoming math test 1 week before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Thinking about an upcoming math test 1 day before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Thinking about an upcoming math test 1 hour before.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Realizing you have to take a certain number of math classes to fulfill requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Picking up math textbook to begin a difficult reading assignment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Receiving your final math grade in the mail.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Opening a math or stat book and seeing a page full of problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Getting ready to study for a math test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Being given a "pop" quiz in a math class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Reading a cash register receipt after your purchase.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Being given a set of numerical problems involving addition to solve on paper.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Being given a set of subtraction problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Being given a set of multiplication problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Being given a set of division problems to solve.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Buying a math textbook.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Watching a teacher work on an algebraic equation on the blackboard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Signing up for a math course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Listening to another student explain a math formula.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Walking into a math class.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix C

Demographic Questionnaire

1.) What is your age? _____

2.) Gender:

Male ☐

Female ☐

3.) When did you last complete a formal math course? (Month and Year)

4.) Do you have math experience from a previous career/job (accounting, engineering, etc.)?

Yes ☐

If yes, what field _____

No ☐

Appendix D

Relationship Between Pre-Intervention and Post-Intervention AMARS Scores

<u>AMARS Question</u>	<u>Pre-Intervention</u>		<u>Post-Intervention</u>	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Studying for math test	2.51	0.94	2.00	0.90
Taking math section of college entrance exam	3.03	1.14	2.57	1.06
Taking a quiz in a math course	3.03	1.05	2.64	0.91
Taking a final in a math course	3.72	1.03	3.03	0.92
Picking up math textbook to begin homework assignment	1.55	0.82	1.35	0.55
Being given difficult homework assignments due next day	2.89	1.20	2.46	0.96
Thinking about an upcoming math test 1 week before	2.44	1.15	1.82	0.86
Thinking about an upcoming math test 1 day before	3.34	1.07	2.50	0.96
Thinking about an upcoming math test 1 hour before	3.75	1.12	2.78	1.13
Realizing I have to take certain number math classes 4 requirements	2.17	1.13	1.78	0.87
Picking up math textbook to begin difficult reading assignment	2.03	1.11	1.64	0.67
Receiving final math grade in the mail	3.00	1.36	2.42	1.16
Opening math or stat book-seeing a page full of problems	2.34	1.07	1.89	0.95
Getting ready to study for a math test	2.06	0.96	1.82	0.72
Being given a pop quiz in a math class	3.75	1.05	3.00	0.98
Reading a cash register receipt after a purchase	1.06	0.25	1.28	0.65
Being given set of addition problems to solve on paper	1.31	0.47	1.32	0.47
Being given set of subtraction problems to solve	1.17	0.38	1.17	0.39
Being given set of multiplication problems to solve	1.24	0.43	1.25	0.44
Being given a set of division problems to solve	1.65	0.85	1.35	0.62
Buying a math textbook	1.17	0.38	1.21	0.41
Watching a teacher work on an algebraic equation on board	1.51	0.78	1.35	0.48
Signing up for a math course	1.20	0.41	1.28	0.46
Listening to another student explain math formula	1.86	0.99	1.92	0.81
Walking into math class	1.44	0.78	1.35	0.55

Appendix E

Math Tutorial

Medication-Calculation Tutorial

University of Alaska Anchorage



Margaret K. Lindley, BSN, RNC

Objectives

Students will verbalize an understanding of how to:

- 1.) Interpret ratios
- 2.) Convert basic units of measurement
- 3.) Carry out medication dosage calculations using the basic formula

2

Ratios

- Ratios
 - Used to indicate the weight or strength of a medication
- May be written 2 ways:
 - 1 : 40
 - $\frac{1}{40}$



3

Example

2 mL: 60 mg or $\frac{2 \text{ mL}}{60 \text{ mg}}$

Read : 2 mL contains 60 mg of the prescribed medication



4

Example

20 units : 1 Liter or $\frac{20 \text{ units}}{1 \text{ Liter}}$



Read : 1 liter contains 20 units of the prescribed medication

5

Converting Units of Measurement

- Nurses must:
 - Understand measurements used for drug dosages
 - Be able to convert between different units of measurement
- Metric system
 - Milliliters (mL), liters (L)
 - Micrograms (mcg), Grams (g), milligrams (mg), kilograms (kg)



Appendix E (continued)

Example

How many milliliters (mL) in 0.7 liters (L)?

1st: Remember 1000 mL = 1 L



2nd : Move decimal 3 places
 $0.7 \rightarrow 0.700 \rightarrow 700.0$
 700 mL in 0.7 L

When units of measurement are the same, just move the decimal place the appropriate number of spaces.

7

Example

The patient has an order for 0.5 grams (g) of ampicillin. How many milligrams (mg) will the RN administer?

1st Step

What do you have?
Grams (g)



2nd Step

Remember
1 g = 1000mg

What do you need?
Milligrams (mg)

8

Next...

3rd Step: Set up proportion

$$\frac{1 \text{ g}}{1000 \text{ mg}} = \frac{0.5 \text{ g}}{x \text{ mg}}$$



4th Step: Solve proportion

$$\frac{1 \text{ g}}{1000 \text{ mg}} = \frac{0.5 \text{ g}}{x \text{ mg}} \quad \text{Cancel out units}$$

$$1 \text{ g (x)} = 0.5 \text{ g (1000) g} \quad \text{Cross multiply and solve for x}$$

$$x = 500 \text{ g} \quad \text{You will give 500 g of ampicillin}$$

9

Basic Formula

$$\frac{D}{H} \times V$$



D = desired medication dose ordered by provider

H = "on-hand" dose (dose written on medication label)

V = "vehicle" or "form" in which the medication is supplied (ex: tablet)

10

Example

Order (D): Give 0.8 mg of folic acid every day

Dose "on hand" (H):
0.4 mg/1 tablet



How many tablets will the RN give the patient?

11

Next: Use Formula

$$\frac{D}{H} \times V$$

D= 0.8 mg

H= 0.4 mg

V= 1 tablet

$$\frac{0.8 \text{ mg}}{0.4 \text{ mg}} \times 1 \text{ tablet}$$

$$2 \times 1 \text{ tablet}$$

$$= 2 \text{ tablets}$$

The RN will give the patient 2 tablets of folic acid.

12

Appendix E (continued)

Questions



13

References

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14

Appendix F

Debriefing script

The purpose of this study was to evaluate math anxiety levels using the Abbreviated Math Anxiety Rating Scale (AMARS). A math tutorial was used with the experimental group in order to determine if anxiety levels increased, decreased, or remained unchanged. The control group did not receive any type of intervention. As a reminder, participation in this study will not have any effect on your grades in UAA courses. Thank you for your time.